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ABSTRACT

This document proceeds from the model presented in ED 088 147 outlining in general form some of the issues and needs in a management information system (MIS) for the National Institute of Education (NIE). This report discusses management information issues and needs more concretely. The discussion is related to planning, developing, and operating one or more of the three major components of an MIS: (1) an output component that has the major task of delivering information to decision-makers so that their decisions are affected; (2) a data management or data processing component where classifications, storage, and analysis of various types occur, and from which manipulated data is retrieved; and (3) the input or data collection component system that collects and feeds in raw data. The report discusses the information requirements of various offices in HEW, information systems needs within NIE, and questions and options related to MIS planning. A plan is suggested for the 12 to 15 months of MIS development. (Author/MLF)

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Report No. M102

A FURTHER LOOK AT MANAGEMENT INFORMATION NEEDS IN THE NATIONAL INSTITUTE OF EDUCATION

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John L. Hayman, Jr.

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CHAPTER I
BACKGROUND, PROBLEMS, AND SPECIAL CONSIDERATIONS

A. Purpose of This Paper

In December of 1971 the author delivered to the NIE Planning Unit a paper titled "Management Information Issues and Needs in the National Institute of Education." The paper presented briefly a model for a "fourth-generation" management information system, outlining in general form some of the issues and needs in the management information area which would be faced by NIE. The report was necessarily general in its recommendations because planning for the NIE structure and operation was itself very preliminary at that time.

The current report represents an attempt to discuss management information issues and needs more concretely. It was prepared during the period when the NIE Planning Unit ceased to exist and NIE itself became a reality. While much planning remains to be done, a great deal more is known about how NIE will be organized and how it will operate than was known in the last months of 1971.

The current document proceeds from the basic management information system model presented in the 1971 report. Since this model will not be presented again, the reader needs to look at the previous report to place what follows in context. The most important feature of the model is its user orientation; the two major criteria for its operational success are (1) that information produced by it have impact on decisions at the different management levels for which its use is intended, and (2) that the impact be beneficial, that is, that decisions are better as a result of it. Stating these as criteria is easy enough; achieving them is extremely difficult. Further, ascertaining that they have been achieved is also extremely difficult.

Any management information system can be seen as having three major components:

1. An Output Component. This has the major task of delivering information to decision-makers so that their decisions are affected. This is undoubtedly the most difficult part of the system to build and operate successfully, and it is the point on which almost all past MIS development efforts have experienced various degrees of failure. As Walter Bauer (1971) has noted, the human/MIS interface causes difficulty. A great deal more will be said about the human interface problem in this paper.

2. A Data Management or Data Processing Component. This is the part of the system into which raw data are fed; where classifications, storage, and analysis of various types occur; and from which manipulated data is retrieved. The data management system is almost always conceived of as being computerized. To many people today, the terms "automatic data processing system" and "management information system" are nearly synonymous. In fact, however, not all data processing has to be computerized. Further, the stress on data processing causes people to think of efficient storage, manipulation, retrieval, and other such activities, rather than impact on and meaning to users, as being the system criteria. The data processing component is at present the most technically advanced of those comprising an MIS, so this component should be the one most easily adapted to system needs.

3. The Input or Data Collection Component. Information delivered to users from an MIS is developed from raw data collected from various sources. The input system, which collects and feeds in raw data, faces a number of technical problems such as validity and reliability, recency of data, and comprehensiveness necessary to meet output needs. This is another place where the MIS has a human interface. Great amounts of data must be collected from the field, from throughout the nation in this instance, and assuring quality control is extremely difficult. Suppliers have to take pains to assure that the information they feed into the system is accurate, and in most cases they have to want to take the necessary pains. The system is clearly dependent on them. Examples of failure to consider the human problem in data collection procedures abound. There are large amounts of duplication among Federal agencies in data collection. Often data are requested at the most inconvenient times in the supplier's yearly operation. Collection formats are used which are inconvenient from the supplier's point of view. A joint problem of the input and processing components is the tendency to

collect and store too much information. The need to be comprehensive and to be in position to meet *ad hoc* or unscheduled information requests often causes systems designers and operators to collect and store vast amounts of information they never use. As Ackoff (1967) comments, an overabundance of irrelevant information is a serious problem in most MIS's.

Almost all of the discussion which follows is related to planning, developing, and operating one or more of these components. Logically, the most difficult to design is the delivery or output component, and here is where the greatest concern should be. Second in difficulty and concern should be the data collection or input component.

B. HEW Expectations and Needs

NIE will need to articulate its MIS operation with the information requirements of various offices in HEW, including the office of the Assistant Secretary for Education and the office of the Assistant Secretary for Planning and Evaluation.

1. Policy and Policy Reporting. The major HEW need is for information relative to policy formulation and policy reporting. In discussing this requirement, various HEW personnel expressed over and over the need for summary statements, for brief, high quality indications of what NIE is accomplishing, and for the avoidance of long project listings. In general, HEW personnel are not concerned with NIE activities on a project basis. It should be possible to locate individual projects if questions arise concerning them, but other than this, information on individual projects is useful only to the extent that it is illustrative.

General types of information-related concerns at HEW are:

a. The quality of research being accomplished in different interest areas and with different target groups.

b. The policy pertinence of different research lines; that is, to what extent do different lines of research match stated national priorities?

c. Policy implications of research lines and findings. What are current and developing national needs in education and what are the research correlates of these? To what extent is current work addressing these needs? What policy changes are needed to fill anticipated gaps?

d. Within the larger context of national priorities and policy, how are policy and priorities set within NIE, and how are plans made relative to them? What are the NIE priorities?

e. What are general findings in the different research lines, and how successfully are these findings being used to affect practice nationally and to solve national problems?

General questions such as these require what might be termed a policy reporting system. They require a type of reporting which has not been successfully accomplished before, according to various persons interviewed, and therefore represent a special challenge to NIE in its MIS development.

Several HEW representatives also stated the need for information on the internal operation of NIE, but again, a highly generalized summary type of reporting is required. HEW needs in this regard appear to be similar to the needs of the NIE Director and his top staff.

Generally, three types of operational information are needed: information on finance, on personnel, and on programs. The OE "Executive Status Report" is at about the right level of specificity. The report is inadequate, however, in supplying the total range of information needed.

2. Financial Information. For financial reporting, HEW needs to know the amounts planned for expenditure in different program areas, in different geographic areas of the country, for different target populations, and with different types of institutions. At periodic intervals (at least monthly) the extent to which actual expenditures match planned expenditures should be reported. The proportion of planned and actual expenditures which represents new money and the proportion which represents past commitments should also be reported. As evidence becomes available, some statement of program impact and its relationship to expenditures is needed. Finally, planned and actual expenditures need to be related to national policies and priorities.

3. Personnel Information. For civil service

employees of NIE, a regular summary statement of average grade in different units compared to planned grade level is needed. Also needed are actual numbers of employees by unit, with breakouts according to educational level, ethnic background, and sex. For exempt employees, HEW needs to know general experience and capability, according to program area; it also needs general level within the organization, ethnic background, and sex. Again, the need is for a general summary statement showing intended levels compared to actual, and implications of discrepancies for NIE operation.

4. Program Area Information. Program information needs have been discussed above. In general, there is the need to know, for NIE as a whole, the proportion of effort going to different program areas, different target populations, and different geographic areas and the relationship of these program thrusts to national priorities.

5. Reporting to Congress. A special area which has not been handled well in the past is reporting to Congress. In general, Congressmen want information at the policy level, much like that described for HEW and top NIE management. However, individuals may also want information on specific projects in their states or districts. The major concerns in legislative reporting appear to be the amount of money being spent and its relationship to intended outcomes. Dollars spent seem to be the most communicative criterion for Members of Congress, and therefore clearly understandable reporting of financial matters is essential. A good deal of cross-referencing is also needed; that is, it needs to be very clear what planned expenditures are according to program areas, target groups, and the like; how close actual expenditures are to planned expenditures; and how these relate to national priorities and needs.

The point was emphasized that it is very difficult, in general, to understand what is accomplished by educational research, as compared to hard areas such as cancer research and space research. In education the relationship of research to existing and anticipated needs is not clear, and there is general agreement that educational researchers have done a poor job in making known the usefulness of their work. For this reason, at least some Members of Congress tend to feel that educational research funds are not carefully enough controlled and that monies are spent without a clear enough assurance of what their impact will be. It is anticipated, therefore, that Congress will keep close tabs upon expenditures within NIE and on their relationship to NIE's impact and meeting of national needs.

6. Legal Requirements. At least two HEW sources indicated that a backup study on legal requirements for information gathering and reporting is needed. Apparently, there is an inadequate understanding of these requirements, with the result that they are often ignored. The Federal Reports Act of 1942, for example, outlined the reporting responsibilities of contractors and grantees, and these responsibilities differ.

C. A Further Look at the Project Grants Information System

In the previous paper, the wide dissatisfaction of users of the Project Grants Information System (PGIS) at the Office of Education was noted. Problems with PGIS were discussed in more detail in the current set of interviews, and they are worth examining here for the insight they give NIE information system planners. Difficulties related to PGIS seem to fall into four general areas: (1) problems with the system itself; (2) problems with data sources; (3) problems with users; and (4) problems with data processing support.

1. Problems with the System. Over and over the terms "over sophistication" and "information overload" were used in describing PGIS. As one person put it, PGIS is a little too sophisticated, operation of it is a little too involved for the purposes it is trying to serve, a little too much data is required for input into the system, and a little too much editing is required on output. Those familiar with the operation of PGIS have cautioned NIE to keep its project and grants information system simple. Start at the simplest level possible and be careful not to over-sophisticate. Make flexibility, quickness of response, and accuracy prime concerns.

2. Suppliers. There is no doubt that suppliers of data to PGIS have been derelict and have contributed in a major way to problems of slowness and inaccuracy. Program officers and other persons both within the Office of Education and in the field have well-defined responsibilities for supplying information to the system. In a large proportion of cases these responsibilities have been ignored, at least to the extent of supplying information far later than it should have been supplied.

One can speculate on reasons for this. Users claim that the amount of data required is burdensome and that their own motivation for the task is low because they do not get feedback and are not aware of the usefulness of supplying data. Be this as it may, the fact is that the system cannot operate without timely and accurate input. This problem can only be solved if, among other things, top management shows its commitment to the extent of "cracking heads," as one person put it, and forcing suppliers to meet their responsibilities.

3. Users. A related problem is that users do not feel they have been sufficiently involved in designing outputs which would meet their needs. A top manager in OE stated unequivocally that output from PGIS has not been properly utilized by top management in OE, partly because of an unwillingness to exert the effort to get the information in its most useful form, and partly because of a general lack of skill in using information for decision-making.

The supplier and user problems interact. In many cases program monitors and analysts act as suppliers of information to PGIS, and they are also users of the information. In general, it appears that there has been a lack of involvement with PGIS, a failure to see the general usefulness of the system, and a lack of any sense of ownership of it by most OE personnel. The same people who complain about unresponsiveness and inaccuracy in PGIS output are often the ones who fail to supply data in the form and in the time frame which the system requires. The supplier-user interaction is a general problem in information system development, of course, and principles of reinforcement apply. When the user and supplier is the same person, the connection between his supplier behavior and the payoff he gets from the system needs to be made explicit. Supportive supplier behavior will be positively reinforced by system output which is perceived to be useful, and it will tend to persist; otherwise, supplier behavior will tend to become perfunctory.

4. Lack of Data Processing Support. One major problem at PGIS is the level of data processing support it has received from the Data Management Center in HEW, which it is required to use. There is widespread agreement both in PGIS and at higher management levels in OE that the Data Management Center is not as responsive as it should be to PGIS or to other OE needs. In general, the feeling is that, since OE has no choice in the matter, it is unable to exert the influence in setting priorities and in getting service that it would in a more competitive situation.

The fact is that PGIS cannot be timely in meeting its own output requirements if it does not receive timely support from its own data processing supplier. As Dorn (1971) has noted, MIS development requires a field-proven computing system with a high degree of availability, configuration, flexibility, and communication capability; an extra large memory; and a good upkeep record. This situation may very well pose problems for NIE. HEW officials have stated that NIE will be required to use the HEW Data Management Center at the beginning, unless strong arguments for some other arrangement can be made.

The question, of course, is whether to use PGIS at NIE. A great deal of time, effort, and money has gone into its development. Its managers state that the problems are being overcome and that it is working better than it is given credit for, and they say, with justification, that NIE will be hard pressed to develop a better projects and grants system. The fact is, however, that PGIS has a bad image, and decision-makers lack confidence in it. NIE may wish to try PGIS for a time and evaluate the kind of service it receives. The projects and grants area is one in which a dual system might be advisable for a time.

D. The Necessity for User Involvement

It was noted earlier in this section that the major problem in MIS development is the people problem. This point came out strongly in the discussion of difficulties with PGIS at the Office of Education. The terms ownership and involvement have been used; clearly these are essential if impact on user decisions is to occur. Users themselves must be involved in system design; otherwise, there is very little chance that their own needs can be met. NSF has followed a task force approach in its own work in involving users. Each organizational unit has had a task force responsible for defining information needs, and the task forces in turn have worked regularly with unit leaders. Other similar approaches are being tried elsewhere. Clearly, the common practice of having automatic data processing and systems experts design and implement an MIS almost in isolation from users cannot work. Users must see the MIS as their own and must make the necessary commitment of time, resources, and personnel to it, or it stands little chance. Even if it works well (or has the capability of working well) users will not perceive it as central to their roles and their performance, and reality to each person is, of course, what he perceives.

One of those interviewed noted that information

indeed is power and that a well organized and effective information system is threatening. It lets people know what is happening and makes accountability a reality. Producing an information system requires people to give up power, and they stand a chance of being held accountable in a way never possible before. The threats are great. The natural resistance to this kind of system will also be great unless it is quite clear to users that the price they pay is worth what they get in return. Solving the people problem will be NIE's most difficult task.

E. Interface of Different Information Systems

A problem which has not been solved in a very satisfactory manner in most governmental agencies is that of interfacing different information systems. The difficulty, basically, is that different systems grow up within agencies for different purposes, and each has its own classification system, definition of terms, files, retrieval procedures, and the like. Sometimes these systems overlap in the information they contain. Sometimes there are gaps so that a bit of needed information is contained in no system or subsystem. Often a total picture in some interest area requires that information be retrieved from more than one such information system. If the separate systems cannot coordinate and communicate with each other--and this appears to be the situation in most instances--then it is extremely difficult to get the overall picture or to identify existing gaps in needed information.

NIE will face this type of interface problem at two levels. First, within the organization there will be a number of separate information system modules or separate subsystems (to be discussed in more detail later). Articulation among these modules will be necessary. NIE will also need to coordinate its own information activities with those of other agencies within the government. If one wants to know the status of research and development in a particular interest area, for example, he may need to examine the activities of five or six or even more agencies. A study recently reported by the General Accounting Office surveyed eighteen federal agencies with regard to research information systems. All but six had some type of automated system, and the remainder either had a manual system or utilized the services of the Smithsonian Science Information Exchange. The study reported that coordination among these different systems has not been achieved.

The GAO report recommended establishment of a Central Authority to control development of a decentralized information network among federal agencies. The Central Authority would operate under policy guidance from the Office of Science and Technology and the Office of Management and Budget, and the Science Information Exchange would play a central coordination role. NIE will undoubtedly wish to cooperate in this effort. In fact, if the Central Authority is operationalized, NIE can adopt the recommended definitions, indexing schemes, and operational procedures with less effort and expense than those agencies which must perform major alterations on existing systems.

CHAPTER II
INFORMATION SYSTEM NEEDS WITHIN NIE

As noted in the opening paragraph of this report, one of the original intents of the current study was to be more specific than the previous report in outlining management information needs within NIE. This means, of course, getting specific as to organizational tasks and responsibilities and unit tasks and responsibilities, and looking at the decision roles at different management levels within the units. The report author and two assistants spent two weeks in July 1972 examining NIE planning documents, attempting to prepare an organization and unit task analysis, and talking with staff members about information needs. While some progress was made, thinking about the specifics of the organization was much too preliminary for precise needs to be specified. In August and September, as task forces were organized and as NIE itself became operational, contact was maintained, and in early October each task force leader in NIE was interviewed. There was a wide

divergence in the concreteness of unit plans, depending largely on whether the unit had been transferred from OE or was being newly organized. Most of the newly organized units were still at very preliminary stages in their planning.

A. Task Force Leader Comments

Task Force Leaders spoke to a limited extent about needs of their units, but they tended to talk more generally about information system problems in NIE. The interview sessions were brief, thus the amount of detail developed was limited. As noted in the previous report, one consultant working part time for a short period cannot really begin to approach the needs assessment job in NIE, and the material in the next few pages obviously represents only a rudimentary beginning.

1. Some Specific Needs and Considerations. Some specific information items mentioned are discussed in this section. Failure to mention a task force here indicates only that the leader spoke more about overall organizational needs than about his own unit. The Career Education Task Force, for example, indicated that, in its current planning activities, it needs information on what training is now underway nationwide and on the current status of research in career education, and it needs followup studies showing why students of different backgrounds do not get jobs.

An aggressive information analysis program will be needed to support the operation of the Field Initiated Studies Unit. Researchers in the field need help in outlining needs, determining what has currently been accomplished and what is currently underway, and identifying gaps. The internal staff of the unit will get into areas of educational research which have not previously been covered adequately, such as economics, anthropology, and jurisprudence. It will also want to explore special areas and be able to note, for example, where significant amounts of educational research have been accomplished and where a breakthrough seems imminent with the right kind of additional effort. Also, there must be a way of identifying areas of such importance that they merit interest, even when there is currently not a sufficient body of research. Generally, Field Initiated Studies will want a distribution of work across a variety of interest areas and disciplines, and it will need strong information support to assure that this distribution is maintained.

To accomplish its general purposes, the New Initiatives group must keep abreast of American education—it must have a broad view of what is going on nationally—and for this there must be a comprehensive digest system which can provide general summary reports. A mechanism is needed for anticipating emerging issues in interest areas so that, through comparing emerging needs with the current situation in the field and with current R&D, New Initiatives can make the best recommendations relative to new program areas. One method of identifying emerging areas involves the use of outside experts. This approach can be useful, but it also has an inherent weakness in that each expert has his own interest area and his own set of priorities. Sometimes such experts are not able to give the larger picture. Therefore, expert judgment needs to be supplemented with summary information derived from other sources.

Applied Studies is likely in the long range to be concerned with directed efforts; that is, it will decide on what a limited number of programmatic areas should be. In the Applied Studies area at least, NIE needs to be responsive to all segments of society in deciding on its activities, and the groups from which it seeks advice should be representative of all segments on a National basis. A wide range of information is, therefore, necessary in the identification of programmatic areas. How much of this information should be supplied by the formal MIS is uncertain.

Researcher Training needs a total of numbers and types of personnel supported for each project and in its total effort. In addition, the number of graduate students employed by projects and the specific degrees they are working on is needed. Crossbreaks giving ethnic background and sex as well as other background characteristics are necessary. An accumulation of costs from year to year is needed by project and by total program.

For specific training projects, information is needed on the number of trainees, the average length of training received in each project, and the cost per unit of time in each training project. Crossbreaks on this type of information should include level of training (post-doctoral, pre-doctoral, etc.) and content (research, development, dissemination, or evaluation.) At the policy level, the Researcher Training group needs some way to predict what R&D personnel are going to be in short supply. It also needs to know how these personnel

problems will relate to R&D needs and programs in the other NIE units.

It is unlikely that any management information system developed by NIE can be of much service to the Experimental Schools Program. Work on an MIS will probably not begin until the Spring of 1973, and, in the normal course of events, eighteen to twenty-four months are required to make a system operational. Activities in the Experimental Schools Program will probably be completed before the MIS can be made fully operational.

2. Supplier-User Problems. A good deal has already been said about supplier-user problems in MIS operation. Several Task Force leaders made comments relative to these problems. It was suggested that if an information supply responsibility is to be placed on a unit, needed staff support should be furnished.

Three additional points were reflected very strongly. First, people feel a pervasive sense of overburdening about data collection. There is a feeling that information systems collect vast amounts of data, much of which they do not use or the use is unknown to the supplier. Second, there is a strong feeling of inadequate prior planning of information system activities. Somehow intended use of information does not seem to be adequately specified in advance, so that too much data is collected and the overburdening problem occurs. Third, intended users are frustrated because they perceive themselves as seldom getting the service that they need. On the one side they appear to be supplying great amounts of data, at considerable cost, and on the other their own needs do not seem to be met. This reiterates the point that users must perceive the usefulness of the information system to their own operation.

There were two suggestions regarding user problems. The first was in the meaning of output. Systems in the past, it was noted, have not taken into account the naivete of users in regard to information use in decision-making. System planners have tended to define MIS outputs in terms of their own conceptions and their own definitions, and these are likely to differ markedly from the conceptions and definitions of the user. Churchman comments that "the true benefit of an information system must be measured in terms of meaning of information for the user" (1968, p. 112).

The second point is that, to avoid some of the user frustration, it is vital to have realistic expectations by all concerned as to what a system can deliver. Frustration develops many times because expectations are unrealistic. The time required to meet an information request, for example, depends on the nature of the request. Sometimes, one or two days is a reasonable time for a request to be met, and sometimes two or three weeks is reasonable.

3. Information Analysis Types. Three types of program-related information analysis which should be at least partially supported by the MIS were identified by Task Force leaders.

First is what was called "discipline-oriented" analysis. This involves looking at all of the existing evidence related to particular interest areas from the perspectives of the researcher and theorist. The general purpose is to define the state of the art in the different disciplines, and from this to identify promising areas of new research. The source for this kind of analysis must be all of the published literature as well as repositories such as ERIC, the National Library of Medicine, and the files of governmental and private agencies. The problem of interface among systems is crucial. What is currently under support in different agencies needs to be related to the corpus of literature so that likely research areas of the future can be predicted. A special concern here is what was referred to in the previous report as the "out-of-kilter" time problem. The need is to identify the kinds of results which will be needed in two or three years or some other future time, but the situation one normally examines is the present. The danger is in planning against present knowledge gaps and needs rather than those which will exist when any research begun now can be completed. Some type of forecasting capability is thus needed.

The second type of analysis was called a "census bureau" analysis. No experimentation or manipulation of natural events is involved in conducting the analysis; rather, the analyst goes to the naturalistic field setting. This is the type of work done in Project Talent, by Coleman, and by others. In it a problem area is identified, then some sampling technique is devised, and raw data are collected from the field, usually on a widespread basis and usually through survey methodology. The data are then subjected to intensive analysis to identify the various relationships. This kind

of analysis can be done at one point in time, as in the Coleman study, or it can be longitudinal, as in Project Talent. A special concern is for compatibility of data and information. Background material may be collected from many different sources, including existing documents. In combining data from different sources into single analyses, making comparisons, and the like, common definitions, compatibility, and comparability become essential. Whether this type of study is handled internally or is contracted to an outside organization, it requires access to a comprehensive educational statistics file.

The third analysis type was referred to as "mission-oriented." In this case, the analyst examines the literature very carefully and draws from it inferences related directly to types of decisions faced by practitioners in education. The goal is to be as practical as possible, and in particular areas to tell practitioners what research indicates the solutions to problems should be. The targeted papers completed in the past in the National Center for Educational Communication are an example of mission-oriented analyses. Clearly the person performing this type of work needs access to all the extant literature, as well as access to work currently in progress throughout the country.

The role of the MIS in these types of program-oriented analyses must be worked out. At the least, the MIS should be responsible for retrieving and/or generating the required background information. The analysis itself is highly labor intensive and requires a high level of expertise in the substantive area under consideration. MIS might take the responsibility for the complete task in particular instances. Other alternatives are to retain outside experts or to have the analysis accomplished by internal staff from one or more of the task forces.

4. Articulation Among Task Forces. Several Task Force Leaders commented on the problem of articulation among their units. Different people in different task forces need to be kept informed about the total operation in NIE. This makes it possible for the total effort to be oriented to overall agency priorities, and it helps to avoid gaps and duplication in effort.

It was also noted that the information system at NIE must be linked into Office of Education Systems on a permanent basis. NIE must have the ability to keep abreast of what OE is doing in different program areas and to coordinate efforts with OE. A closely related problem, the difficulty of tracing a project from its inception and birth to publication and dissemination, was noted. For this, not only must units be articulated, but the project and grants system must be linked to the financial system and both of these must in turn be linked to the dissemination system.

5. Use of Dissemination Task Force Resources. Personnel in the Dissemination Task Force noted the willingness of their own group to participate in planning and developing the management information system within NIE. Their past activities, of course, have been in the information field. They also suggested that a system now in existence, but not currently active, could be utilized at least on a temporary basis to track operational projects. This is the Current Projects Index (CPI), operational from 1966-1970 at the Office of Education. The Dissemination Task Force still has the software for the CPI and could operationalize it quickly. The advantages would, of course, be quickness and the need for few developmental resources. The current NCEC contractor could handle the processing.

6. Library. Several task force leaders discussed the need for a good library at NIE. They were not certain whether a library should be considered part of the information system, but this matter should be decided in the near future.

7. Agency Management. Central administrative and management needs appear to be very similar to the policy-level needs discussed in the section on HEW requirements earlier in this report. At a general level, information is needed for three purposes by top management. The first is planning. Here the need is for analytical information rather than the type of information required for specific program development. Top management needs help in identifying and evaluating general program options. It needs summary statements of emerging national needs, of what is happening programmatically, relevant to these needs in NIE and in other governmental agencies, and what the likely alternatives may be.

Second, information should help management in budget formulation and in presentation of budgets. Here the problem is resource allocation to different program areas according to priority decisions, as opposed to specific line-item budgeting procedures.

The third purpose for information at the top level is in management analysis. This includes manpower analysis for the total organization and for units within it. It includes total organizational analysis which related total performance to total priorities. Finally, it involves an analysis of the operation of the separate units and subunits according to their own goals and priorities.

More specifically, management of the agency (as opposed to long-range planning) requires information in personnel, finance, and programs. In the personnel area, summary information for the total agency as well as for units within the agency and for programs is needed. Sub-breaks should include sex, ethnic background, and professional level. Regular information in terms of job authorization fulfillments is needed, as is a running account on average grade level. For the exempt category, there should be a running account by organizational unit of expertise as well as other background characteristics. In the finance area, the needs are similar to those expressed in other sections of this paper. Top management needs to know the level of actual expenditures in different program areas as compared to planned expenditures. It needs to know where overruns and underruns occur, the extent of their occurrence, and why. Concerning programs, top management needs the capability of requesting and receiving information on individual projects. But on a regular basis, it needs summary reporting which allows management to determine the extent to which actual activities are supporting agency policies and priorities.

The top management group expressed the opinion that NIE should begin with a "lean" management information system; that is, a system that is limited in scope, first meets top priorities, and performs well. The notion of information overload came through strongly in their discussion. The feeling was that information systems in other governmental agencies have attempted to do too much too soon.

This kind of advice appears to fly into the face of the need for comprehensive, long-term planning, as recommended by management scientists and systems specialists. The two notions are not necessarily contradictory, however. NIE should prepare a long-range plan for its MIS needs, but there is no reason why this plan cannot specify starting the development at a simple level and building it slowly over time.

B. Needed Information System Functions and Components

The discussion results and background information indicate that NIE will need an information system to serve at least nine distinct functions, as described below. These descriptions will be brief because some of the functions were discussed in the previous paper, "Management Information Issues and Needs in the National Institute of Education," and because content is discussed in other sections of this paper. The number of separate information subsystems (or system components) needed to serve these functions and the way each is structured is somewhat arbitrary, depending on such things as subsystems which are already available and on decisions relative to the overall MIS plan on where to place certain individual information items. There will be a number of separate components, however, and as noted in the previous paper, the different components should be conceived as modules in the total information system.

1. Policy. Clearly there is a need for a policy level information system component. As Figure 1 (below) indicates, some of the policy information involves aggregating and summarizing from lower levels. This is the type indicated when top managers say that they need to see in very general form the overall picture regarding programs, finances, and personnel. Some policy level needs are unique, however, and not a matter of merely aggregating. Included here are issues of national practices, emerging national needs in different areas of education, and concerns of national client groups concerning educational practices. So far as we can discern, this latter type of policy information has been gathered largely through paper preparation, expert panels and the like, and has not usually been developed as a part of an information system in governmental agencies.

2. Finance. A budget/finance component is obviously needed, and it should supply information at different levels of specificity to different decision-makers throughout the organization. For the immediate future, use of the Office of Education Financial Management Information System (OEFMIS) seems a necessity. Experience with OEFMIS may demonstrate that it serves NIE needs adequately and no further development in this area is necessary. It will, of course, be necessary to articulate this component with other information system components at NIE.

3. Projects and Grants. A Projects and Grants information system is also essential. The opinion seems to be widely shared that currently available systems are not adequate and that this is an area in which NIE could well begin its own developmental efforts. One general purpose of such a system is to follow projects from birth to completion, from the initial proposal stage to dissemination. This requires tracking through the

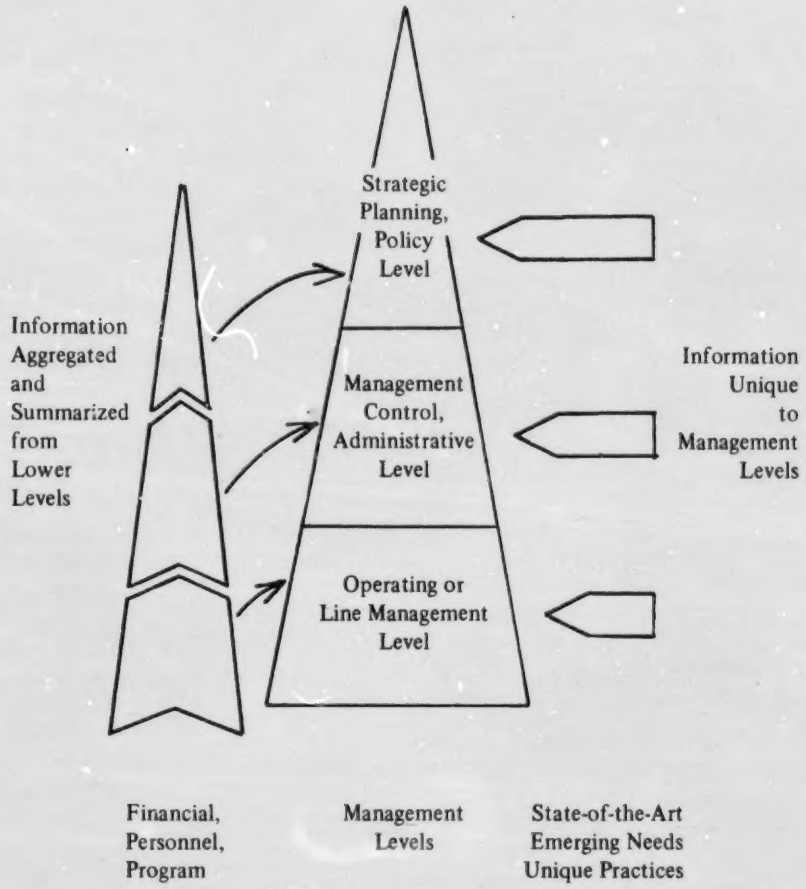
Strategic Planning, Policy Level
Management Control, Administrative Level
Operating or Line Management Level
Information Aggregated and Summarized from Lower Levels
Information Unique to Management Levels
Financial, Personnel, Program
Management Levels
State-of-the-Art Emerging Needs Unique Practices

Fig. 1: AGGREGATED AND UNIQUE INFORMATION NEEDS

proposal approval and negotiation stage, through the operational stage, and through dissemination and impact.

The author of this paper and his associates prepared for NIE a plan for an interim proposal processing system. The system is manually operated and quite simple, based on the supposition that the number of proposals processed in NIE during the first two or three years of its existence will not exceed 3,000 to 3,500 a year. The proposed system only carries through the completed contract stage and not into the operational stage. The most favorable feature of this system is its simplicity; it provides for complete tracking and for control over the process, without resort to sophisticated computer processing. Its greatest deficits are its inability to handle large volumes of proposals efficiently and its lack of any printout capability.

4. National Descriptive Capability. In discussions with people in OE, HEW and NIE, the point was made over and over that, particularly for policy and long-range planning, there must be a way to get information on the status of education nationally. The National Center for Educational Statistics (NCES) currently has the responsibility within HEW for supplying status information, and no doubt NCES will provide the major portion of this service to NIE. Some problems currently exist in the area, however. One is the difficulty in summarizing to a general enough level that broad pictures of the total national situation can be obtained. Also, NCES is seen as rather cumbersome and slow in meeting requests. Finally, some NIE task force leaders indicated the need for the capability to survey, on a national level, the relevant publics concerning educational problems and priorities; this capability would have to be developed. Work in the descriptive status area should have a high priority among NIE information system activities.

5. The Status of Current and Past Research. This is the area referred to in the previous report as archival. As the discussion indicates, planning and policy making, as well as outlining of programmatic priorities, require a clear grasp of available knowledge and the likely outcomes of current efforts. Views of the national situation in education and emerging needs related to it are gained from status information (the type discussed in the preceding paragraph). Information about knowledge and products which can be applied to these needs is gained from archival information. A number of systems contain information of this type. The ERIC system within NIE contains it, as do systems within a number of other federal agencies and other systems such as the National Technical Information Service, Datrix (a retrieval system for dissertations), *Psychological Abstracts*, and the like. The Smithsonian Science Information Exchange currently serves as a kind of collecting point for all agencies, but it is far from being complete. The network proposed for the Office of Science and Technology would assist in this area. In the meantime, NIE needs to work with its own dissemination staff and with representatives of other agencies in assuring that this information need is met.

6. National Resources. There needs to be a complete file of all types of agencies—universities, colleges, state departments of education, local education agencies, profit and non-profit private agencies—and individuals available to do work on different NIE programs. This file needs to include the past performance record of the different resources, it needs to be readily accessible, and it needs the capability for cross-referencing with the projects-grants and archival components.

7. Internal Management. Records must be maintained on activities proposed for each unit and for the agency as a whole. This includes such things as program announcements, issuance of requests for proposals, start up of new programs, project and program evaluation, site visits, report preparation, and the like. These activities need to be scheduled and a system made operational which indicates at relevant decision levels when the activities are due and when they have been accomplished. The question remains as to how much of this type of information should be collected and maintained by each unit as opposed to a central MIS. In any event, certain information should be circulated among units so each will have a picture of what the others are doing. Development of this information system component is directly dependent on the development of management plans for each of the units and for NIE as well.

8. MIS Evaluation Component. As noted in the first MIS report, a management information system must be dynamic. Experience has shown that it is virtually impossible to serve users at a satisfactory level on initial system implementation, so that cycles of evaluation and redevelopment must be run through several times. In addition, information needs keep changing so that the

system itself must change. To accomplish the needed evaluation and redevelopment, the MIS will need to have an evaluation planning group.

9. Personnel. A type of information which managers consistently indicate they need is that related to personnel--numbers employed against authorization, average grade level, and the like. In some organizations which must keep data on large numbers, personnel is a part of the formal MIS, but this is not likely to be true at NIE. The personnel section will most likely keep its own records. However, because the MIS must have access to personnel data to perform its functions, arrangements will have to be made to supply this data on a timely basis.

C. The Overall Picture

A number of questions need to be answered relative to NIE information system needs, and a number of options need to be considered. These will be discussed in the next chapter. In the meantime, one general conclusion which can be drawn from the above discussion is that each level of management has certain unique information needs and that the total system cannot consist simply of a data-gathering operation which aggregates and summarizes from the bottom up.

This might be shown graphically as in Figure 1. Three general management levels are usually discussed in the management science literature: the strategic or policy level, the middle or administrative level, and the operating or line level. This is quite often conceptualized as a pyramid, with the area of each section of the pyramid relating approximately to the number of people involved in that management level. Such a conceptualization is shown in the middle of Figure 1. Clearly, some of the information needs at the top can be met simply by aggregating and summarizing from the bottom. This includes personnel information, financial information, project and program management information, the three information types which top management consistently says it needs. It is quite clear also, however, that some of top management needs, and some of the needs at other levels are unique. As an example, in the matter of assessing national needs in determining what new initiatives and organizational priorities should be considered, a good deal of information on the state of education in the country and on the opinions and desires of different client groups must be gathered and fed to the policy level. This obviously cannot be aggregated from any basic data collected below.

CHAPTER III
QUESTIONS AND OPTIONS RELATED TO MIS PLANNING

A number of major questions and options need to be considered as NIE proceeds with planning for its management information system.

A. Degree of Centralization. One issue is the degree of centralization for the MIS; i.e., how much of the total information needs of NIE will be served by a central unit and how much will be left to the individual units? The advantage of decentralization is that the system stays under the control of the unit head and is more likely to stay simple and relatively unsophisticated. Also the unit has more immediate access to data, and if operations can be kept manual, overall costs may be lower.

Major problems revolve around articulation. It has been noted a number of times in this paper that different information systems, both within the government and without, need to articulate with each other and to be able to exchange information. Independent development of separate systems is almost certain to increase this problem. A related problem is that often an analysis will require information from two or more systems, and retrieving it and performing the necessary crossbreaks and other manipulations is difficult when separate systems are involved. Development and operation of large information systems can be costly; often economies of scale can be obtained

through centralization. Finally, control over the total is much easier in a centralized setup.

Currently there is disagreement nationally as to the degree of centralization desirable. NIE will most likely want some information kept in individual units—probably that which can be handled manually and which applies only to the unit's operations—and it will want some to be kept centrally.

B. Degree of Contractor-Consultant Help. In planning for, implementing, and developing its management information system, NIE will have options as to the amount of contractor and consultant help it wishes to use. At one extreme, outside help can be held to a minimum; in this case, NIE would develop its own staff with complete capability for accomplishing the job. At the other extreme, a minimum staff would be retained, with almost all of the work done by contractors and consultants. The best course probably lies in the middle. Building up internal staff provides greater control, greater concern for the organization's problems, and it may be more economical in some instances. However, it also causes a loss in flexibility, with difficulties in securing needed levels of expertise on special occasions. A difficulty with outsiders is that they often do not get deeply involved with an organization's problems; their interest tends to be at a less intense level than those whose futures are more directly at stake. The general pattern appears to be to use internal staff in positions and for tasks which are known to be full-time and permanent, and to use outside resources for tasks which require high levels of expertise for short periods and/or which are temporary. An exception is that data processing services are sometimes purchased on the outside on a long-term basis.

C. Order of Development. A choice exists as to whether to begin development of a total comprehensive management information system for NIE at once, or whether to space the period of development over time and develop the system component by component. The over-time option exists because NIE can temporarily use system components which now exist at OE.

The advantage of developing a total comprehensive system is that, at the earliest time, NIE's management information needs would be met, according to the agency's own priorities and operations. Using other systems will be partially successful at best because these systems have been developed for other purposes. To the extent that the delivery of and use of information actually relates to the quality of management, NIE will suffer in failing to do the complete job from the start at as high a quality level as possible. A number of agencies have developed information system components piecemeal and then have discovered that these do not articulate well and do not provide the service needed. In some cases, completely new systems have been developed to overcome this problem. One advantage of the piece-at-a-time approach is that it allows a smaller expenditure per year on the developmental process. It also allows concentration on the most crucial management information areas, and it seems to follow the philosophy voiced by a number of top managers to start the system at a simple level and develop it slowly in evolutionary fashion.

In any event, a number of existing systems must be used on a temporary basis because at least twenty-four to thirty months will be required for the beginnings of a new system to become operational. An interim proposal processing system has been proposed. As noted elsewhere, the dissemination task force has software which could be made available on a temporary basis as a project tracking system. Other OE systems exist and will be used. The Smithsonian Science Information Exchange might be used as a project information system while NIE plans its own.

D. Extent of Redevelopment. Four options are available in the incorporation of existing components into a new system. They are: (1) adopt the system exactly as it is for NIE use; (2) adopt it with only minor modifications so that expenditures for redevelopment are slight; (3) adopt it with major modifications, in which case moderate to heavy developmental expenditures are required; (4) develop a completely new component. Careful evaluation of existing systems is important because of the relationship of amount of developmental costs to this question. The necessity for using current OE systems can be worked to advantage in this regard; they can be carefully evaluated in actual use in NIE over the months ahead and the decision of what to do with each of them can be based on actual experience. This approach places a premium on evaluation.

E. Data Processing Support. The matter of data processing support was discussed earlier in some detail. Data processing is essential to information system operation; assurance of proper levels of support is an

important part of MIS planning and implementation. NIE appears to have four possible courses of action in this matter: (1) it can depend on the HEW computation center for its total data processing needs; (2) it can secure its own computer and related equipment; (3) it can purchase services from an outside vendor; or (4) it can follow some combination of these approaches. (Note that this may not be a real option. NIE may be forced to use the HEW facilities, at least at the beginning of its operation.)

Most information systems specialists who are interviewed during the course of this study stated that they would prefer to purchase services from an outside vendor. This allows greater flexibility on their part, it allows them to avoid building large staffs which have to be kept busy even in slack periods, and it allows them to impose accountability. However, two of what appear to be highly successful information systems have chosen to have their own computing equipment. These are the National Library of Medicine and the Management Information System of the National Science Foundation. In both cases, responsible persons stated that the decision was based on sufficient volume of work within the agency and the increased control that was afforded.

F. Manual Versus Automatic Processing. In the preceding material, use of manual data processing as opposed to computerized data processing has been discussed, and the suggestion has been that manual processing be used to the extent possible, especially in the beginning stages of information system development. There can be no doubt, however, that ultimately most data processing in NIE will be handled by computer; the volume and complexity of the processing tasks will leave no alternative. In fact, a number of existing computerized systems, including those at NCES, OEFMIS, NCEC, and the Smithsonian Science Information Exchange, will be used, and therefore, automatic processing will be employed right from the start.

Given that a major part of the work must ultimately be computerized, what can be handled manually in the immediate future, and what is the advantage in doing it this way? The principal advantage is that it allows a kind of trial-by-experience, evolutionary approach, in which the system can be developed with a premium on usefulness at all decision levels. In other words, make the system work the way users from the top down want it to work, and base the permanent system on the procedures which are developed through this process. Note again the importance of regular feedback from users and careful evaluation. One advantage of this approach is that it develops confidence in the operation and helps overcome the psychological mistrust that many people seem to have with regard to automatic data processing. Confidence in ADP builds slowly; one big mistake with a system can undermine a lot of successful effort.

Plans for a manual interim proposal processing system have been developed. What other parts or components of the information system might use manual processing? The proposal tracking system itself is a possibility. One of the most successful tracking systems in HEW, that of the Division of Health Evaluation, is manual. (This system is described in more detail in Appendix A.) The system operates well and users are satisfied with it. Furthermore, the costs in developing and operating it have been low. The question is whether it can handle the volume which will be present at NIE. Currently, the Division of Health Evaluation has about 400 active projects, and they expect to go to about 800 over the next two or three years. The Divisional Director indicated that he and his staff are aware that some automation of the system may be necessary in the future. The complete system or any part of it is available to NIE.

As noted previously, individual units within NIE will probably have their own sub-systems for information which is used entirely within the unit. These unit systems may be manual. Generally, the question of whether to have manual as opposed to automatic data processing in information systems depends on four factors: (1) periodicity of use; (2) volume of information which must be handled; (3) the nature and number of reports required for regular users; and (4) the nature and number of *ad hoc* requests made of the system.

G. User Needs Assessment. As indicated earlier, current thinking indicates that a management information system must be user oriented. Its two major criteria are that it have impact on decisions at all management levels planned for in its design and that this impact be positive, i.e., that the decisions be improved as a result of having the information. The point has also been made that the system can only be user oriented if users are involved in its planning and development, and

if its output is based directly on user needs. As anyone experienced in information system development will say, however, the problem with this is in determining exactly what the user needs will be. The most obvious approach is to go directly to users and ask them, but it turns out in practice that they have great difficulty specifying what they require.

There are a number of approaches to assessing the needs of information system users. NIE will probably want to utilize several of these in conducting its own needs assessment.

1. Interview Approach. As noted, the most obvious technique is to interview users directly. This is valuable in that it provides a general picture of the individual's role, the tasks he faces in the role, and the general levels of information he thinks he needs. Also, it focuses his attention on the information system problem and can be a start toward involvement and establishing ownership. Periodic interviews with users are valuable, but they cannot do the complete job. A useful device in surveying users is the critical incidents technique, that is, to have users note decision situations they faced when they did not have information they needed. The power of this approach can be increased with a series of periodic interviews; those interviewed are alerted to the technique at each interview session and made sensitive to information needs.

2. Empirical, Time Sampling Approach. A second approach involves the collection of empirical data on information needs on a time sampling basis. This has been followed successfully in the Department of Defense and other agencies. It involves sampling users periodically through the year and asking them what decisions they had to make within a recent time period (no more than one week) and determining with them the kinds of information needed. This approach can involve direct interviewing, the use of questionnaires, or both, and it has the great advantage of being based directly in actual experience. It can also involve the collection of critical incidents in much the same manner as mentioned earlier.

3. Task Force Approach. A very effective technique is to set up one or more task forces which have the responsibility of specifying information output for the system. At NSF a separate task force was organized for each organizational unit. Each of the task forces prepared specifications for its unit and interacted regularly with other task forces so that the total effort could be articulated. In another project with which the author has been involved, a single task force was set up with two or three representatives from each separate organizational unit. Task force members work under strict time constraints and they must have sufficient released time to do the job; information output specification cannot be added to an otherwise full-time load. The task force members interact directly with their unit leader on a regular basis. Thus the leader's involvement is secured; he participates regularly in planning, but his time requirement for this task is held to a minimum.

4. Analysis of Current and Past Activities. An important step in existing organizations is to analyze carefully information relating activities currently underway and those from the past. This includes such items as current reports, current information system outputs, and current forms and other input devices. A standard technique is to prepare charts showing information flow through the organization. In this type of analysis it is, of course, important to examine the unofficial information systems, which often exist in individual units and sub-units, as well as the official systems and components. Since NIE is a new organization, the value of this type of analysis is questionable. Something is to be gained, of course, from an analysis of relevant units and sub-units within OE, but only to the extent that organizational purposes and activities overlap.

5. General Survey Techniques. A number of general survey techniques can be useful in assessing user needs. The interview has been mentioned above and is important. The questionnaire can be used in various situations throughout the needs assessment and planning processes, and it is valuable as an evaluative device. Sometimes very simple techniques can provide good evaluative information. For example, a simple snap-out form, which has the recipient indicate the relevance of what he has received, has been used for both regular and *ad hoc* reports.

H. Interface with Other Information Systems. Interface with other information systems has been discussed earlier. In this regard, NIE has three major concerns. First is the extent to which NIE will use existing systems on at least a temporary basis in lieu of having its own system components at the beginning. The

systems existing at OE seem the most likely candidates for this usage, though the Smithsonian Science Information Exchange may be desirable for at least the project tracking component. Aside from availability of other systems, items of concern in making this decision include the level of support which will be obtained elsewhere: will NIE have a high enough priority so that its needs are met on a timely and comprehensive basis? A second question is the validity and reliability of output from other systems. Information lacking these qualities can, of course, be worse than useless. A third area is simply the extent to which outputs from other systems match needed outputs identified at NIE.

A second matter related to interface is the extent to which NIE will use support from other agencies in planning and developing its information system. Representatives from various agencies, including the National Science Foundation, the Smithsonian Science Information Exchange, the National Library of Medicine, and HEW have indicated a willingness to give NIE all or parts of systems which they have paid to develop, and also to provide personnel support in setting up these components.

The third interface matter concerns exchanging information with other agencies. As indicated, NIE will want to cooperate with the Office of Science and Technology in its attempt to develop a government-wide information network. It may wish to develop more direct relationships with such agencies as NSF, OEO, DOD, and NIH, whose substantive concerns overlap those of NIE to some extent. It is obviously essential to exchange information with the Office of Education.

I. Training and Orientation. As noted in our previous report, some type of training and orientation for all information system users will be highly desirable. The whole matter of commitment, ownership, and the like has been discussed in detail and will not be repeated here. In addition, most decision makers do not possess sufficient skills in the use of information. Involvement in system planning helps to solve this problem; training and orientation are also needed. The NSF management information system training program would appear to be a model. Every full-time employee of that agency, from its director down to the clerk-typist, will receive some type of training. Content and time differ, of course, according to the level and the decision-making responsibility of the target audience. Each employee will receive an average of about ten hours of training, with 25 hours or more for those who will help to operate the information system. A fuller description of this program is given as Appendix B.

J. Policy Support. Problems involved in supplying information to support policy making and priority setting have been discussed before. NIE needs to determine how much of this activity it wishes to assign to its information system and how much it will choose to handle through the conduct of specific studies. As noted, supplying policy support information is a most difficult task in designing a management information system. Because of its importance and difficulty, early attention should be paid to it. Undoubtedly, the management information system will serve top management and the advisory council to some extent. The exact role needs to be specified.

K. Research and Development on Management Information Systems. As this report makes abundantly clear, the common practice in management information system development is to place responsibility in the hands of systems analysts and planners who are perceived as peripheral to the main organizational structure, to develop sophisticated systems which fail to meet user needs, and to generate general dissatisfaction with the total process, with subsequent breakdowns in functioning. The possibility of approaching the matter in an R&D framework seems to have escaped most organizations. This approach has been taken at the National Library of Medicine, however, and it appears to be highly successful. NLM has an annual budget of about thirty million dollars. Of this it puts some ten percent, or three million dollars, into an R&D effort intended to improve its own operation. Generally, the work is in the communications engineering area, with attention to many of the problems mentioned in this report. There is an internal R&D group in the system, into which are placed outside experts for a period of a year or less. The R&D effort has contributed substantially to the growth and development of the National Library of Medicine, and it has contributed generally to knowledge about information systems. NIE might very well profit from this example.

L. The Advisory Function. NIE will undoubtedly need some type of semi-independent knowledgeable group to serve in an advisory capacity to the MIS development effort. Decisions need to be made about the way the group will be structured, the individuals to serve on it, and how they are to be involved. NIE will want to

include persons knowledgeable in management techniques, data processing and computer utilization, systems analysis techniques, file development and maintenance, and communication science, as well as other areas. It will want some of its own staff and staff from OE on the advisory committee. It will undoubtedly be desirable to have representatives from other governmental agencies, as well, perhaps, as from the university and business sectors. Most important is to assure that very talented, experienced people are chosen. The advisory committee will oversee the total development of the MIS. It will assist in the development of a long-range master plan. It will also assist in assuring that the components are articulated and the effort is unified. Such matters as standard definitions, standard formats for file materials, and common formats for data processing should be watched.

CHAPTER IV
A PLAN FOR THE FIRST PHASES OF MIS DEVELOPMENT

With NIE operation now underway, work on the management information system should begin immediately. During the study it became evident that information needs already exist, needs which were not being met at the time this report was prepared.

As suggested in the first report, NIE's first task is to appoint a full-time MIS director. A strong, knowledgeable person who has the confidence of the Agency Director and his top staff is needed. MIS development will require a substantial commitment—of budget and staff time—if it is to be successful. The MIS director must be a person who can gain and hold this commitment. Also, he must be able to gain the respect and the cooperation of information system staff in other governmental agencies.

We see five major phases in development of the information system at NIE:

Phase 1

Start-Up. Several steps must be taken before system design can get underway. These are the pre-planning or initial steps and should begin immediately.

Phase 2

Interim Operation. Design of the NIE information system will require twelve to fourteen months, and another year or so will be involved in bringing up the system. In the meantime, NIE will be operating and its information needs will have to be met on an interim basis through the use of existing systems.

Phase 3

System Design. This is a time-consuming phase during which specifications for the information system at NIE will be prepared. As noted, it will require more than one year, and it will involve staff commitment from all Agency units.

Phase 4

System Implementation. After the design has been completed and adopted, implementation of the system will begin. Another twelve to fourteen months will be required before new components will operate fully. Note that interim operation with available systems will continue during this period, and there will be dual operation for a time. All new and redeveloped system components must be fully checked out and known to be operable before old systems are shut down, otherwise the Agency MIS stands a high probability of a serious blunder, which will undermine confidence and substantially damage the whole effort.

Phase 5

Operation and Redevelopment. The final phase is system operation and redevelopment. As noted earlier, the MIS must be dynamic, both because of continuing needs for improvement and because of changes in information needs over time. A strong evaluation component is essential.

In the next few pages a plan is suggested for the twelve to fifteen months of MIS development. This plan is not presented as a finished product; it will need revision as active work on the system gets under way. It is intended rather as a starting point for the MIS director and his staff.

1.0 Begin Start-Up (Pre-Planning) Operations.

1.1 Appoint MIS Director.

1.2 Set up space and facilities.

1.3 Determine additional staffing needs for the MIS operation and recruit additional staff.

1.4 Appoint Advisory Committee.

1.4.1 List the specialties needed on the Committee.

1.4.2 List three or four potential members for each position.

1.4.3 Put choices in priority order.

1.4.4 Contact choices and make appointments.

1.5 Meet with top MIS staff in related agencies.

1.5.1 Immediately establish close working relationships with MIS personnel in the two most directly related agencies, the Office of Education and HEW.

1.5.2 As quickly as possible, meet and establish working relationships with other agencies, including the Office of Science and Technology and its Committee on Scientific and Technical Information (CASATI), the National Science Foundation, the Office of Economic Opportunity, the Smithsonian Science Information Exchange, the National Institutes of Health, the Department of Defense, and the National Technical Information Service.

1.5.3 Secure descriptive documents from other agencies which include details on definitions, terminology, classification systems, files and file structures, software packages, hardware requirements, retrieval mechanisms, and the like.

1.6 Prepare a detailed development plan, including activities, time required and completion dates, personnel requirements, and other needed resources, including contractors and consultants.

1.7 Discuss the development plan with top NIE staff.

1.8 Revise the plan.

1.9 Meet with the Advisory Committee.

1.9.1 Review the complete effort and its purposes.

1.9.2 Discuss the development plan.

1.9.3 Get suggestions for changes; also begin working on long-range (up to five years) goals.

1.10 Revise the development plan.

1.11 Meet again with top NIE staff.

1.11.1 Present the revised development plan.

1.11.2 Finalize the plan.

1.11.3 Secure approval of NIE Director and commitments of the Director and top staff.

1.12 Print the development plan and

distribute it to top NIE staff, the Advisory Committee, and relevant staff in other agencies.

1.13 Make arrangements for the involvement of contractors and consultants in the project.

1.13.1 Outline precise tasks to be performed.

1.13.2 Advertise need; publish RFP(s) if competitive bidding approach is selected.

1.13.3 Select contractors and consultants and make formal arrangements for their involvement.

2.0 Begin Interim MIS Operation (This phase begins at the same time as Phase 1.)

2.1 Specify immediate information needs and the criteria that delivered information must meet.

2.2 Identify available information systems and components. (OE is the obvious first place to begin. This step should be conducted in conjunction with 1.5 above.)
Note: The estimated cost of using the available system or component, the extent to which each matches identified needs, its availability and the willingness of those operating it to make it available, its feasibility (how much difficulty will be encountered?), and immediacy (how soon can use begin?).

2.3 Select interim systems. (Note that alternatives might be selected in some cases; for example, both PGIS and the Smithsonian SIE might be used for handling projects and grants.)

2.4 Make formal arrangements and begin utilization.

2.5 Conduct a formal and complete evaluation of each system. (The importance of this step should be obvious. As noted in the paper, substantial developmental costs can be saved if existing systems or components can be adopted or modified.) Evaluate in terms of:

2.5.1 Actual costs;

2.5.2 Flexibility: How quickly are information requests met? Is delivered information in the requested format? Can outputs be cross-referenced with those of other systems?

2.5.3 User satisfaction (on an individual basis).

2.5.4 Agency satisfaction: Do its needs get priority status? Does the arrangement promote productive relationships with other agencies? Are there major irritations, such as overly burdensome input requirements?

2.5.5 NIE staff needs related to use.

3.0 Prepare System Design

3.1 Determine information output requirements. (Note that this step is logically placed first in designing the system; everything else must follow from output requirements.)

3.1.1 Determine HEW reporting requirements from NIE, including those of the Assistant Secretary for Education. List the data elements and the time of delivery of each.

3.1.2 Determine reporting requirements for other governmental agencies.

3.1.3 Determine internal information needs in NIE.

3.1.3.1 Appoint an MIS

Coordinator for each major organizational unit (from each Task Force, according to current terminology). The Coordinator's MIS activities will average about two days a week. He will work with the unit leader and other major staff.

3.1.3.2 Hold a two-day retreat to provide detailed information on and gain commitment to the MIS developmental effort. In attendance should be the NIE Director and selected top staff, MIS staff, unit leaders, unit MIS coordinators, and representatives from any contractors.

3.1.3.3 Have each coordinator, working with unit staff, prepare a narrative statement of processes—purposes, tasks, responsibilities, activities: describe key roles within each unit, including decision responsibilities; prepare information flow charts for each unit; prepare a requirements paper for each unit, including required reports, users and their responsibilities, major decisions made during the year and their timing, and information elements related to decisions content, frequency, and format; and prepare an information item dictionary for each unit.

3.1.3.4 Merge unit reports into an NIE requirements paper.

3.1.3.5 Merge unit information item dictionaries into an NIE data dictionary. In the process, choose common definitions of terms, code information elements, eliminate duplication, and include users and delivery dates for each item. (The information item dictionary will be a basic working document for the MIS. It will be revised many times as planning and development proceeds.)

3.1.3.6 Prepare a tentative information element list for each user. Indicate content, delivery date, and format.

3.1.3.7 Have each user first examine his list alone and indicate for each element whether it is satisfactory or needs changing in some way; needed additions to the list should also be indicated.

3.1.3.8 Have coordinator interview each user, using list as basis of interview process. Major additions to the list can be expected during this process.

3.1.3.9 From the updated listings, revise the Agency information item dictionary.

3.1.4 Put together information

requirements outlined in steps 3.1.1, 3.1.2, and 3.1.3 and prepare an Information Delivery System Plan. This will include as output specifications for the complete MIS a listing of each information element; content of each element; combination of elements into reports, according to individual users, with format; delivery date for all reports and other outputs; and delivery method. (note that this plan should include specifications for the central MIS as well as for the subsystems to be maintained in each unit.)

3.1.5 Concurrently with the other information requirement steps, start critical incidents reporting by each intended MIS user. Critical incidents reporting will be explained at the retreat (item 3.1.3.2).

3.1.5.1 Supply each user with a set of brief forms made up as suggested in Figure 2.

3.1.5.2 Have each user complete the forms on an exception basis; i.e., he completes one when he has a key decision for which needed information is not available.

3.1.5.3 The unit MIS Coordinator will handle this system; he will give any needed additional explanations, offer reminders, and be responsible for collecting the forms on a weekly basis. (If there were no incidents during a week for a user, a single form will be submitted with "none" written on it.)

3.1.6 Using critical incidents and other additional needs identified over time, revise the Information Delivery System Plan.

3.1.7 Meet with the Advisory Committee (about six to eight months into the project) and review the information item dictionary, the Delivery System Plan, and other documents prepared to date.

3.1.8 Revise documents.

3.1.9 Meet with NIE Director, his top staff, and unit leaders; review documents; make any needed revisions and get approvals.

3.2 Concurrently with the above system design steps, continue to meet with MIS representatives in other agencies.

3.2.1 As NIE planning proceeds and needs become more specific, discuss overlap, needs for interface, usability of their components, etc.

3.2.2 Work out common descriptors, definitions, files, retrieval mechanisms, files, etc., so far as possible.

3.2.3 Work out arrangements for exchange of information, common planning, and other functional relationships.

3.2.4 Continue to evaluate the adaptability of other systems and components to NIE needs.

3.2.5 Determine what assistance other representatives can give in the adaptation of their systems and components.

3.3 Define subsystems and components. (This step should begin after 3.1.9. Note that the modular concept is being followed here.)

Name _____ Date _____

Position _____

Nature of Decision _____

_____

_____

_____

_____

Additional Information Needed _____

_____

_____

_____

_____

Fig. 2: SUGGESTED CRITICAL INCIDENTS FORM

3.3.1 Name and describe each component. Note general function, outputs (derived from the information item dictionary and the Delivery System Plan), and the way the function is currently being performed.

3.3.2 Determine for each component whether it is to be adopted as is from another agency, adapted from another agency with some redevelopment required, or developed new for NIE.

3.3.3 Place components in developmental order, that is, the order in which work on each will begin. This will be based on components available from other agencies, evaluations of components which have been used in the interim operation, and the importance of the intended component output as compared to what is currently available.

3.3.4 Prepare a long range developmental plan, indicating the disposition of each component, the date work on each component is to begin and the development time required, and expected costs.

3.3.5 Review plan with Advisory Committee.

3.3.6 Revise.

3.3.7 Review plan with NIE director, his top staff, and unit leaders.

3.3.8 Revise and get the Director's approval.

3.4 Outline Data Management Needs.

3.4.1 Determine data processing support needed for new and redeveloped system components.

3.4.2 Determine data processing support needed for interfacing with other information systems, including systems and components which will continue to serve NIE.

3.4.3 Determine data processing support (including "executive monitor" support) needed for articulation within the Agency. This will include articulation among central system modules, articulation of the central system with unit systems, articulation among unit systems exclusive of the central systems, and individual unit system needs.

3.4.4 Outline manual data processing needs.

3.4.5 Development specifications for data processing needs, including hardware and software packages.

3.4.6 Outline and evaluate options for obtaining needed service.

3.4.7 Meet with the NIE Director and his staff and choose the best option for obtaining data management support.

3.4.8 Make necessary arrangements.

3.5 Outline the Data Input System.

3.5.1 Based on the information item dictionary, determine the raw data which must be collected. Include content, source(s), collection dates, and collection method.

3.5.2 Locate possible secondary data sources, i.e., other agencies which

collect the data. Possibilities include NCES, other OE units, and other governmental agencies. Make arrangements to collect all possible data from these secondary sources.

3.5.3 Design forms and other collection devices.

3.5.4 Outline collection procedures.

3.5.5 Prepare manuals.

3.5.6 Design editing and quality control procedures.

3.5.7 Meet with Advisory Committee, review progress to date, review data collection manuals and procedures.

3.5.8 Revise data collection manuals and procedures.

3.5.9 Present data collection plan to NIE Director and top staff; revise and get approvals.

3.6 Concurrent with activities 3.4 and 3.5, design orientation and training program.

3.6.1 Determine who is to receive orientation and training.

3.6.2 Outline orientation and training program modules. For each, list objectives, content, duration, and target groups.

3.6.3 Outline process for developing and administering modules.

3.6.4 Review orientation and training plan with NIE Director and Unit Leaders.

3.6.5 Revise plan and get approvals.

(System design will run well into the second year of the MIS development project. Two additional phases, which are not developed in detail for this paper, will remain.)

4.0 Implement the design.

5.0 Operate the system and redevelop it as needs arise.

APPENDIX A

A BRIEF DESCRIPTION OF THE MANUAL DATA PROCESSING SYSTEM IN HEW'S DIVISION OF HEALTH EVALUATION

A manual projects-grants information system is being developed and is partly operational in HEW's Division of Health Evaluation. Work started on this system in March 1971, and the basic approach was to avoid anything grandiose--rather, to develop something more limited but workable.

The system is planned with three components: a Documentation Center, a Project File, and a Follow-up File.

1. The Documentation Center which is not implemented yet, is intended to be an umbrella documents library system. The Center will have the capability of filing and indexing all project-related documents that come into the Division, including letters, final reports, tapes, specially produced materials, and other such items. The objective is to be able to retrieve any document within three minutes.

2. The Project File system is working now, and, according to the division director, is working quite successfully. This is considered the most important part of the larger system. As each project is initiated, a file (in the form of a notebook) is set up. This is a background file which contains everything up to the signing of the contract, including brief summaries of prior work in the area, memoranda from the secretary and others related to the area, literature reviews and the like. The top sheet in the file is a check list related to intended file contents. Other file items include:

   a. The RFP.

   b. The Winning Proposal. (Since all proposals in the Division follow a fixed format, information can be located easily.)

   c. Follow-up contracts and Amendments.

   d. A directory of different people involved, including the principal investigator, the project officer, etc. Titles, addresses, and telephone numbers are included.

   e. Project schedules.

   f. Budgets.

A section on project methodology may be added.

3. The Follow-Up System is designed to follow and allow monitoring of active projects. It also consists of a single file which covers all projects. Included for each project are milestone events and other critical dates for projects. This system allows very close control. Each day a secretary goes through the file and makes a calendar. This includes what events are supposed to occur that day, what reports, letters, and other documents are due that day, and what reports, letters and other documents are due at specific times (usually one week) in the future. Contractors are reminded in advance when reports and other items are due, and they are held to delivery schedules. The Division Director noted that the close control caused a lot of adverse reaction from contractors in the beginning, but that this had subsided as expectations of close monitoring were set.

A printed manual describes each component of the system. It describes the component and its structure and purpose, and it provides details on how it is to operate. It also describes the duties of each Division staff member with regard to system operation. The system is headed by a File Maintenance Officer, the only full-time staff member. It was designed by a contractor, who worked with the Maintenance Officer. The system is completely manual at present. All or parts of it could be automated, but the Division Director does not see any need for automation in the immediate future. Automation will probably be introduced when the Documentation Center becomes operational. At that time, the Follow-Up system will probably be automated, and there will probably be automated abstractors and descriptors. The project files are expected to be kept basically as they are.

An obvious limitation of the system is its ability to handle large volumes of projects. The Health Evaluation Division currently has about 400 projects, and it expects to go to about 800 in the next four or five years. The current system will work for this volume. Whether it would work for 4,000 projects is questionable. The question, of course, is whether this system would work for NIE, and the answer depends on the number of projects NIE will have. If the number does not exceed 1,000 or so, the system would work. Beyond that, more study would be required.

APPENDIX B

A DESCRIPTION OF THE MIS TRAINING PLAN AT THE NATIONAL SCIENCE FOUNDATION

A. Introduction

As with any computerized system, the success of the Management Information System depends, to a great extent, upon the people who use it. Experience has shown that a complex computer system can be most effectively used by personnel who have a thorough knowledge of its operation. Since the MIS will provide support to nearly all parts of the Foundation it is important that everyone have a basic knowledge of computer concepts as well as the specific MIS and technical knowledge necessary to his particular area of interest. In order to provide this knowledge the MIS Project Office in conjunction with the Personnel Office will establish a MIS orientation and training series. The orientation portion of the series will present a variety of conceptual topics dealing with computers, the hardware, and time sharing.

The training portion of the series will present courses designed to equip NSF personnel with the specific skills needed to effectively use the MIS.

B. Orientation and Training Needs

Everyone within the Foundation can benefit from some degree of orientation or training, but individual needs will vary depending upon experience and responsibilities. To provide a framework for organization the MIS series will offer subjects tailored to the needs of three groups of NSF personnel: secretarial and clerical staff, operations staff, and management.

The management group will encompass NSF personnel at a Division Director or higher level. Information for this group will be mostly conceptual with emphasis on areas of special interest to the participants.

The operation staff group will be composed of Section Heads, Program Directors, Associates, Assistants, and anyone having a definite non-routine need to use the system. Subjects for this group are designed to provide a thorough conceptual knowledge of the overall MIS as well as in-depth knowledge of specific MIS applications. Optional courses in programming skills will be offered to those who have a need for writing programs for local applications.

The secretarial and clerical staff group will be composed of those who have only infrequent contact with the MIS and those who will perform routine input functions. Subjects recommended for this group will present an overview of the entire MIS as well as in-depth coverage of specific MIS applications. In addition to the three broad categories listed above, DMSO personnel will need training in both technical and MIS topics. Technical training will be provided as part of the new computer procurement and by a continuing DMSO program. MIS training will be supplied by the MIS orientation and training series. Close coordination is needed to insure that the special information needs of DMSO personnel are met and to eliminate duplication of effort in the development of training courses.

C. Method of Presentation

The MIS orientation and training series will be conducted by the Personnel Management Assistance Section of the Personnel Office. MIS will provide assistance in dealing with the technical aspects of the series. As each subject becomes available for presentation, PMA will prepare a detailed plan for its presentation.

D. Subjects to be Presented

- A1 Computer Concepts I
- A2 Computer Concepts II
- A3 Computer Concepts for Management
- B1 NSF Computer Hardware Orientation I
- B2 NSF Computer Hardware Orientation II
- B3 NSF Computer Hardware Demonstration for Management
- C1 Survey of MIS Concepts
- C2 MIS Concepts I – Proposal Processing System
- C3 MIS Concepts II – Program Management System

C4 MIS Concepts III – Administrative Operations System
C5 MIS Concepts IV – Analytical Projects System
C6 MIS Concepts V – Local Management System
C7 MIS Concepts for Management Time Sharing Concepts
E1 Terminal Operation
F1 Time Sharing and Terminals for Management
G1 Specific MIS Applications
H1 Introduction to Programming
H2 Programming in BASIC
H3 Programming in FORTRAN
H4 Programming in COBOL

E. Section E consists of a set of flow charts and is not included in this appendix.

F. Subject Descriptions

The following pages contain a general description of subjects to be covered by the series. Included are the objective of the subject, main topics to be presented, prerequisites, and an estimated duration.

A1. Computer Concepts I

Objectives

To build a basic understanding of the history and functions of computer systems.

Topics

Basic business functions
Historical development of computers
Functional components of a computer
Actual components of a computer
Functions of the people who use the computer
How computer instructions can accomplish a business procedure

Duration

Two hours

Prerequisites

None

A2. Computer Concepts II

Objective

To build a thorough knowledge of the characteristics and functions of computers and programming

Topics

Testing and debugging processes
Basic concept of computer programming
Overview of programming languages
Programming languages characteristics
Sequential and direct access devices
Computer hardware configurations
Operating systems
Teleprocessing characteristics

Duration

Three Hours

Prerequisites

Computer Concepts I

H1. Introduction to Programming

Objective

To provide basic computer programming concepts for beginner programmers

Topics

Numbering Systems
Stored Program Concepts
NSF Hardware Description
Data and Word Concepts
Assembling
Compilers
Flow Charting
Coding
Debugging
Operating Systems
Teleprocessing Operations
File Concepts
Practical Exercises

Duration

Five Days

Prerequisites

Time-Sharing Concepts

H2. Programming in Basic

Objective

To provide the skills necessary to write programs in the Basic language effectively

Topics

Basic Program Structure
Basic Character Set
Basic Statements
Input/Output
Practical Examples

Duration

Three Days

Prerequisites

Introduction to Programming

H3. Fortran Programming

Objective

To provide the skills necessary to program simple applications in the FORTRAN language

Topics

Definition of Terms
Arithmetic Expressions
Relational Expressions
Logical Expressions
Replacement Statements
Control Statements
Specification and Data Statements
Format Specifications
Input/Output Statements
Program Structure
Practical Exercises

Duration

Three Days

Prerequisites

Introduction to Programming

APPENDIX C

SOME INFORMATION ITEMS KEPT IN INDIVIDUAL UNITS AT OE

Category A – Policy and Its Implications

1. General NIE policies re: programs
2. Hierarchy of national education problems
3. Hierarchy of national education needs
4. Hierarchy of priority funding areas
5. Legislative directive
6. State of arts in education R&D for each priority area
7. State of NIE programs and capabilities re: national priorities
8. Needs in
   a. personnel
   b. hardware
   c. software
   d. funds
9. Comparative data on relative amounts for various high priorities

Category B – "External" Breakdowns of Information

1. Program or project information by:
   a. social class studied
   b. ethnic group
   c. age group studied
   d. sex group studied
   e. level of educational institution studied
   f. type of institution studied
   g. relative R&D thrust
   h. geographic distribution
2. Program or project information by:
   a. funding
   b. percentage of total budget
3. Separate listings of above for;
   a. proposals approved
   b. proposals disapproved
   c. characteristics of investigators

Category C – Task and Process Information

1. Procedural guides to individual tasks and processes
2. Task analyses of personnel positions

Category D – Financial Information

1. Budget justifications
2. Needs assessment, personnel
3. Needs assessment, funds
4. Needs assessment, material
5. Personnel expenses, salaries
6. Committed funds
7. Obligated funds
8. Nature of supports to projects
9. Amounts of support, specific
10. Amounts of support less than $10,000
11. Amounts of support between $10,000 and $100,000
12. Financial ledgers
13. Comparisons-dollars allotted to dollars spent

Category E – Internal Program Information

1. Status of proposals
2. Project files
3. Grant documents
4. Background on funded proposals
5. Projected or realized product of each contract/grant

6. Project logs: dates and fundings

7. MBO's (management by objectives information)

8. Final reports

9. Findings by topic of research

10. Findings by project or program

11. Project:
    a. descriptors
    b. identifiers
    c. abstracts
    d. evaluations
    e. products

12. Resources for:
    a. projects
    b. programs
    c. task forces
    d. divisions
    e. bureaus

Category F – External and Broader Related Program Area Information

1. Topical publications

2. Catalogue of federal programs

3. Bibliography of ERIC and other published reports from transferred programs

4. List unpublished reports of same

5. Projects from BRICS and/or CPI

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